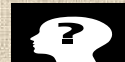


Recall the steps of the scientific method:



- 1) Have a question
- 2) Do Background Research
- 3) Hypothesize
- 4) Experiment
- 5) Interpret (Analyze) Results
- 6) Form Conclusions
- 7) Communicate and extend



Experimental Design: Controls and Variables

- **CONTROLS**: Things held **CON**stant during an experiment.
- **VARIABLE**: The only thing that you **VARY**, or change, during your experiment
 - Varying more than one thing makes your experiment "*invalid*", or *worthless*!

Note about "Controls"...

- Sometimes the "Controls" are called "controlled variables" because they *could* change, but you're keeping them constant on purpose.

Note

a "Control" = a "Controlled variable"

"If ____, then ____" format for Hypotheses

- "If a plant receives fertilizer, then it will grow to be bigger than a plant that does not receive fertilizer."
- "If I put fenders on a bicycle, then they will keep the rider dry when riding through puddles."

Practice!

- Watch the following experiments on Mythbusters and identify the variables and controls and conclusions.

But if we change something in the experiment, the results will change

- Yes. You change something, and this causes a change in the results *IF* the two things are related.



- We give these special names:
 - Independent variable
 - Dependent variable

Independent Variable (IV)

is selected by the experimenter to determine its relationship to an observed phenomenon.

Ex: If I want to measure the effect of the amount of sleep on a person's health, I will choose different amounts of sleep for participants of a study (like 4 hours, 6 hours, 8 hours and 10 hours).

Dependent Variable (DV)

is the observed phenomenon.

Ex: The health of the participants in the sleep study will be measured. If it is related to sleep, then it will *DEPEND upon* the amount of sleep they were allowed to have (the IV).

In other words:

- Independent variables answer the question "What do I change?"
- Dependent variables answer the question "What do I measure?"

Back to Hypotheses:

- "If ___, then ___" hypotheses make it easy to identify the IV & DV.
- If you change the IV like this, then you will observe a change in the DV.

Identify the IV and DV.

"If I open the faucet, then it will increase the flow of water."

Example:

IV: Open the faucet
(what experimenter changes)

DV: flow of water
(how result changes)

List the IV and DV.

- 2) "If a plant receives fertilizer, then it will grow to be bigger than a plant that does not receive fertilizer."

IV =

DV =

- 3) "If I put fenders on a bicycle, then they will keep the rider dry when riding through puddles."

IV =

DV =

List the IV and DV.

- 4) "Raising the temperature of a cup of water will increase the amount of sugar that dissolves."

IV =

DV =

- 5) "As I use electronics for increasingly long periods of time, the Energizer AA battery will maintain a higher voltage than other batteries."

IV =

DV =

Answers:
IV and DV.

- 1) "If I open the faucet, then it will increase the flow of water."
- 2) "If a plant receives fertilizer, then it will grow to be bigger than a plant that does not receive fertilizer."
- 3) "If I put fenders on a bicycle, then they will keep the rider dry when riding through puddles."

Answers:
IV and DV.

- 4) "Raising the temperature of a cup of water will increase the amount of sugar that dissolves."
- 5) IV = use electronics for increasingly long periods of time
DV = maintain a higher voltage

Practice!

- Write an "If/Then" hypothesis that will test the relationship between fertilizer and seed germination
- Circle your Independent Variable
- Underline your Dependent Variable

Example Hypotheses:

- If fertilizer is added to seeds, then they will *germinate faster than seeds without fertilizer.*
- If fertilizer is added to seeds, then they will *start growing slower than seeds without fertilizer.*

Materials that are available:

- petri dishes
- Fertilizer (liquid MiracleGrow)
- Radish seeds (up to 20)
- Water
- Graduated cylinder
- Soil
- scale (for mass: grams)
- Paper towel, tweezers, water, rulers,